VMAP
Vegetation Management Alternatives Program

A Guide to Opportunities

Prescribed Fire as a Vegetation Management Tool

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Wildfire is the dominant natural agent affecting boreal landscapes in northern Ontario. Fire plays an important role in maintaining and enhancing plant and animal diversity in northern forest ecosystems (Kelsall *et al.* 1977). If we want to manage our natural resources sustainably and simulate the effects of natural disturbances we need to recognize the role of fire in northern forest ecosystems and find ways to build it into our forest management strategies.

Prescribed fire is the deliberate application of fire to forest fuels on a specific area under predetermined conditions to fulfill silvicultural, wildlife management, sanitary or hazard reduction requirements. Prescribed fire is a resource management tool we can use to achieve a number of objectives at the site level. For example, one of the common silviculture systems used in the boreal forest is clearcutting. Some of the sites harvested under this system are very nutrient rich and are rich in competitive species following harvest. Prescribed fire, if applied properly, can be used as a post-harvest vegetation management tool to control or enhance these species, depending on the site objectives. Using prescribed fire following harvest can simulate the natural disturbance effects of wildfire.

Boreal forest plants have evolved fire adaptive traits to reduce mortality and ensure regeneration following fire. Because we have some understanding of these fire adaptive traits in forest plants, we can use prescribed fire as a vegetation management tool. For example, with prescribed fire we can improve early growth of crop trees by temporarily inhibiting the growth of competing vegetation or we can use fire to enhance wildlife habitat by promoting the establishment of specific plant communities.

This technical note reviews the effects of prescribed fire on selected tree species and associated vegetation in boreal Ontario. We focus on fire effects on vegetation, plant response to fire and their fire adaptive traits, ecological relationships between vegetation and site, successional trends following fire, and prescription development using fire for vegetation management. This technical note was inspired by the work that Sybille Haeussler conducted for British Columbia's Ministry of Forests and Forestry Canada (Haeussler 1991).

Ontario
Ontario's Living Legacy

Sound knowledge of site conditions, natural successional stages, and fire behavior is required to successfully use fire for vegetation management. The purpose of vegetation management is not to eliminate all competing plants but rather to temporarily direct more of the site's resources into fulfilling the management objective (Walstad and Kuch 1987). Different burning frequencies, intensities, and seasons favor different plant species (Haeussler and Coates 1986, Bell 1991, Haeussler 1991). To develop vegetation management strategies that effectively use prescribed fire as a silvicultural tool, we need to understand the response of plant species and communities to fires of different severities.

Fire Effects on Vegetation

The effect of fire on vegetation is largely determined by how much organic matter is consumed by the fire and how much heat penetrates into the soil (Rowe 1983). This is also known as fire severity. Fire intensity (the actual release of energy) is not as relevant to the survival of plant parts buried in the soil as are depth of burn and increases in soil temperature. For example, on sandy soils with shallow organic matter depths (e.g. northeast ecosite ES 2 or northwest ecosite ES 13), fires of low intensity (low energy release) may have a correspondingly greater effect on vegetation because a larger proportion of the organic matter is removed, resulting in seeds, rhizomes or roots near the surface being destroyed (Rowe 1983).

Fire severity, as measured by the amount of organic matter removed, is determined by:

- fuel conditions (amount, type, size, arrangement, depth and moisture content)
- weather conditions before and during the fire (temperature, humidity, wind speed and precipitation)
- site conditions (position on slope, aspect, soil texture and soil moisture)
- ignition method and pattern (Haeussler 1991).

In this technical note we consider two general classes of fire severity:

Low Fire Severity

- most of the moss/litter layer is charred but not ashed
- approximately 30 to 60 percent of the shrub canopy has been consumed
- some leaves and small twigs remain on plants and are either unharmed or slightly singed
- fifty to 70 percent of fine fuels are removed (McRae *et al.* 1979)
- some heavy fuels are removed (10 - 20%)
- less than five centimetres of duff is removed

Medium to High Fire Severity

- moss/litter and duff layers are consumed and only ashes remain on the soil surface
- more than 60 percent of the shrub canopy has been consumed
- only stems greater than 1.5 cm in diameter remaining or charred remains of the main stem
- most fine fuels are removed (70 - 100%)
- moderate amount of heavy fuels are removed (greater than 20%)
- more than five centimetres of duff is removed

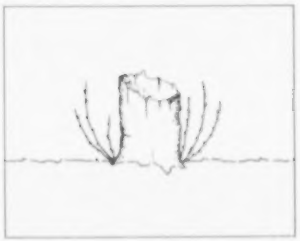
Response of Plant Species to Fire

The response of vegetation to fire depends on the degree to which above-ground plant parts such as stems and buds, and below-ground plant parts such as roots, rhizomes, and buried seeds are damaged or destroyed. The degree of damage to plant parts is largely determined by fire severity. Fire severity also influences post-fire environmental conditions (e.g., the degree of soil organic matter loss, nutrient status, and seedbed availability), which affects the distribution pattern and rate of re-vegetation. The response of an individual plant species to a fire depends on its fire-adaptive traits and its physiological and morphological characteristics at the time of burn. Characteristics of a plant species that influence its response to fire include:

- fire adaptive survival mechanisms
- rooting characteristics
- phenology (development stage of a species at the time of burn, which influences its flammability, status of its carbohydrate reserves, and seed maturity)
- age, health, and vigor.

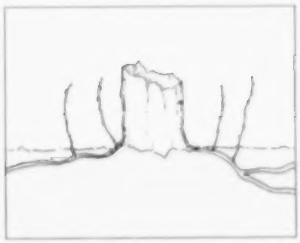
Fire-adaptive Traits

The plant species described in this note have developed fire adaptive mechanisms that either protect them from damage by fire, enable them to regenerate following fire, or equip them to be aggressive invaders of burned areas. These fire-adaptive traits are summarized in Figure 1. Many species utilize several of these mechanisms in combination, to maximize their chances of survival in a fire environment.

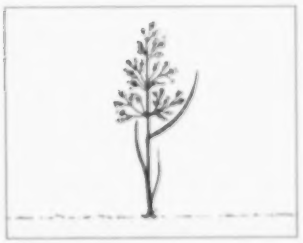


Sprouting
Establishment of new shoots from dormant buds at the root collar or stem base (e.g. blueberry, Labrador-tea, white birch)

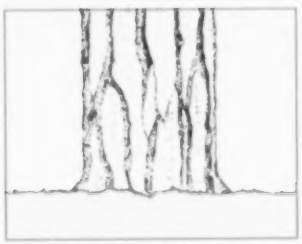
Seed Banking
Storage of seed in the organic or mineral soil, which remain dormant but may germinate following fire (e.g. pin cherry, wild red raspberry)



Suckering
Establishment of new shoots from underground buds located along the original plants' roots or rhizomes (e.g. trembling aspen, balsam poplar)

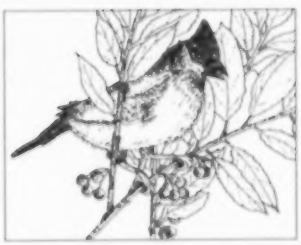


Flowering and Seed production
Post-fire environment stimulates seed production (e.g. Canada blue-joint grass, fireweed)



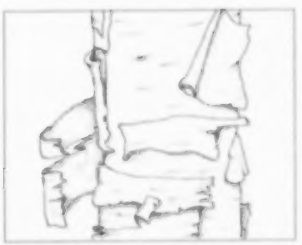
Insulating Bark
The tree's living tissue is protected from lethal heat (e.g. red and white pine)

Cone and Fruit Opening
Heat from fire melts resin between cone scales and releases stored seed (e.g. jack pine, black spruce)



Seeds Dispersed by Wildlife
Seeds that germinate well on burned sites are carried by birds or mammals (e.g. mountain ash, choke cherry)

Seeds Dispersed by Wind and Water
Seeds that germinate well on burned sites are carried by wind or water (e.g. fireweed, white birch)



Flammability
Plant parts contain flammable materials to encourage fire (e.g. white birch bark, blueberry leaves and stems, bracken fern leaf litter)

Figure 1. Fire-adaptive traits of boreal forest plants.

Rooting Characteristics

The relative resistance to fire of boreal plant species may be ranked according to the nature of their root systems (**Figure 2**). Sensitive species are those which develop shallow root systems in surface organic layers, with fibrous roots, stolons or rhizomes above or in close proximity to the mineral soil surface. Resistant species develop root systems in both the surface organic layers and upper mineral soil, usually with fibrous roots and rhizomes growing within five centimetres of the mineral soil surface. Highly resistant species are those developing deep root systems, with rhizomes growing more than five centimetres below the mineral soil surface, or have deep tap roots capable of regenerating by means of adventitious buds (McLean 1969, Flinn and Wein 1977, Arnup *et al.* 1995).

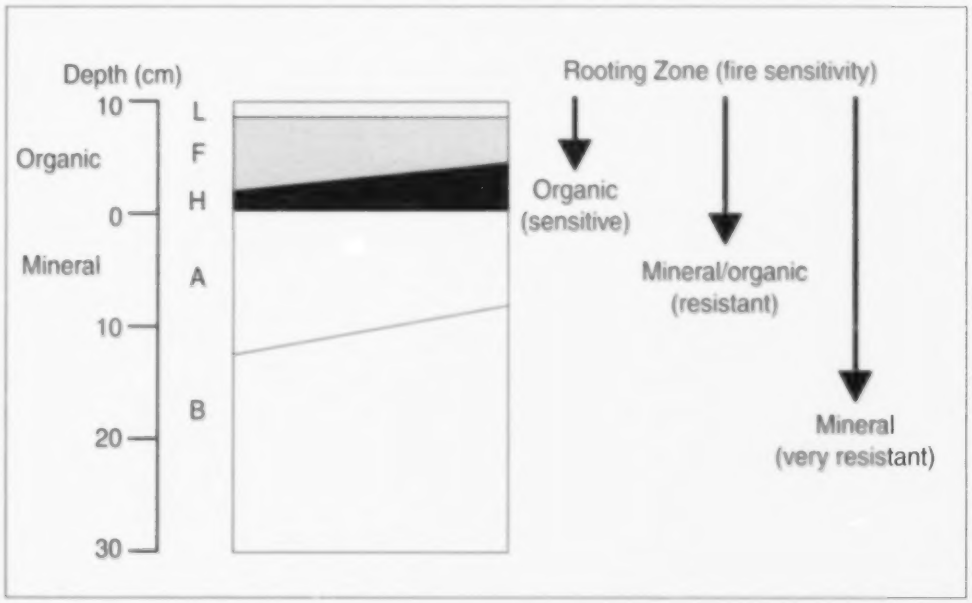


Figure 2.
A typical soil profile and rooting zones of boreal plant species and their relative resistance to fire.
(L, F, H, A, B - soil horizon descriptions (refer to Taylor *et al.* 2000)).

Generally, the abundance of species with sensitive root systems will be unchanged or somewhat reduced by a low intensity fire, and greatly reduced by a medium to high severity fire. Species with resistant root systems will recover quickly and increase in abundance following a low severity fire, but will be reduced by a medium to high severity fire. The abundance of species with highly resistant root systems is usually enhanced by fire. Plants with highly resistant root systems (e.g. trembling aspen or bracken fern) may respond vigorously to a high severity fire that stimulates suckering from adventitious buds on deeply buried roots (Lavender *et al.* 1990).

As fire severity increases, more heat penetrates into the mineral soil and destroys or severely hinders the reproductive capabilities of below-ground plant reproductive organs and stored seeds. More effective control of resistant species might be achieved by burning under conditions of higher soil moisture content. This produces moist heat and steam which is transferred to underground plant parts during severe fires. This moist heat is more damaging to living tissue than the dry heat to which underground plant parts are exposed to in drier soils (Ahlgren 1960). However, duff is a very effective insulating material, especially when wet. Temperatures hot enough to destroy buds, roots, rhizomes or buried seeds rarely occur more than a few centimetres below the depth of burn (Haeussler 1991). The total depth and moisture content of organic layers are therefore important considerations in predicting likely plant responses to fire.

Phenology

Phenology refers to the development of a plant through different stages over the course of the growing season, for example, stages of root growth, bud break, flowering, leaf flush and expansion, stem growth, cessation of growth, seed or fruit maturation, leaf senescence, and leaf drop (**Figure 3**). Changes in the physiological and morphological condition of the plant occur at different stages of development. These include changes in moisture content, carbohydrate reserves, and the maturity of its reproductive structures. A plant's phenological condition at the time of burning affects its flammability, its capacity to sprout or sucker, and its ability to regenerate from seeds or fruits.

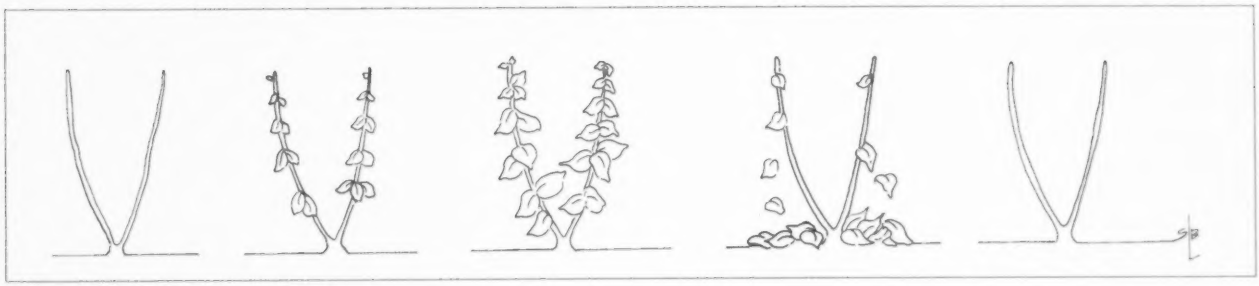


Figure 3.
Diagrams of a shrubs' phenological condition through a growing cycle (Haeussler 1991).

Flammability

Flammability is lowest when the moisture content of the aboveground plant parts is high. The overall moisture content of plant foliage varies; some species, such as fireweed, have a naturally higher moisture content than others. Moisture content also depends on the time of year. It is usually lowest in the spring before sap flow and leaf flush, and in late summer and early fall when leaf drop occurs.

Flammability is also affected by the presence of flammable substances within the plant. For example, all parts of low-bush blueberry contain high levels of flammable materials. The bark of jack pine and white birch is highly flammable. Some plants, such as bracken fern, produce highly flammable litter that is slow to decompose. Accumulation of this litter produces a highly flammable duff layer. These plant traits are thought to be fire-adaptive mechanisms that encourage burning, which stimulates reproduction of these species.

Carbohydrate Reserves

As a plant begins to grow in the spring, its stored carbohydrate reserves are mobilized. By late spring or early summer, during the period of most active growth, these reserves are at their lowest levels. Following maturity, carbohydrate reserves are again accumulated in preparation for the next growing season.

Plants that reproduce by sprouting or suckering are most sensitive to fire during the period of active growth (late spring and early summer) when carbohydrate levels stored in roots and protected stem tissue are lowest. Plants are least sensitive to fire during dormant periods (usually from late summer to early spring, depending on the species), and usually recover quickly following fire because they have an abundance of stored carbohydrates and an abundance of dormant, protected buds. However, even though plants are highly sensitive to fires during late spring, prescribed burns conducted during this period may have little effect on plant suppression because of the high moisture content of soils, duff layers and foliage. Fires conducted during dry periods or in early summer are the most effective at suppressing competing vegetation (Bell 1991, Haeussler 1991).

Seed Maturity and Banked Seed

Plants that use seed production and dispersal traits to regenerate respond differently depending on the time of year at which burning occurs. The time of year determines whether seeds are immature or mature, consumed by the fire or stimulated to germinate by the post-fire environment, or dispersed after the fire onto freshly burned, receptive seedbeds (Cushwa *et al.* 1967, Haeussler 1991). In the boreal forest, seed maturity generally occurs from mid-summer to early fall, depending on the species (Bell 1991).

The response to fire of plants that bank their seed (maintain viable seed within the soil) depends on the relative number and depth at which stored seeds are buried in the mineral soil. As buried seed depth increases (which is partly a function of stand age and time since last stand replacing fire), the amount of banked seed that survives a fire increases. Also, the amount of seed that survives a fire generally increases with the amount of seeds that have been dispersed onto a suitable site before a fire. Generally, greater control of seed banking species can be achieved with increasing fire severity and depth of burn.

Buried seed are found in the shallow surface layers of the soil and duff. Kellman (1970) found 84 percent of the viable seed in the upper five centimetres of the soil, where many seeds will be destroyed during a fire. Successful establishment of those that survive or are disseminated into the area may be further restricted by the availability of favorable microsites (Leck *et al.* 1989). Buried seed reserves are not extensive in coniferous forests. Often seeds are not viable or quickly lose viability. Many are lost to predators. The dominant species are rarely characterized by abundant seed bank reserves, but the early successional species are well represented (e.g. grasses and sedges, wild red raspberry).

Fire generally promotes recruitment from seed banks through removal of accumulated litter and elimination of competing species. Many seeds are tolerant to heat (Daubenmire 1968) and if covered even slightly with soil, can survive a relatively intense fire. In contrast, above ground vascular plant tissue is easily killed by heat (Wright and Bailey 1982). Therefore available seed can provide important information in predicting the effects of fire. Understanding the seed bank is necessary prior to manipulation of disturbance regimes; unwanted species originating in the seed bank may become established.

Age, Health and Vigor

Fire sensitivity varies with the age of the plant. Young plants are typically the most vulnerable because they have not had time to develop fire-adaptive structures (e.g. thick insulating bark or extensive root systems). Some plants rely on one type of fire-adaptive trait when they are young (e.g. seeding) and another when they are mature (e.g. sprouting or suckering). Generally, resistance to fire increases with age but declines as the plant becomes overmature and begins to lose vigor. Plants in a vigorous, healthy condition have a higher resistance to fire and are more likely to recover quickly.

Summary of Plant Species Characteristics and Responses to Fire

Table 1 summarizes the primary modes of vegetative reproduction, rooting zone, seed dispersal methods, seed banking capability and reproductive response to low severity versus medium to high severity prescribed fires for selected common boreal forest plant species. For additional information on these species, refer to the Field Guides to Autecology of Crop and Competitor Species for northeastern and northwestern Ontario (Buse *et al.* 1992, Arnup *et al.* 1995).

Vegetation – Site Relationships

Site characteristics such as moisture and nutrient regime, position on slope, aspect, soil texture, soil depth, the presence of root restricting layers, and organic matter depth influence the occurrence, abundance, and distribution of vegetation species and communities. These site characteristics determine the possible types of pre-and post-burn vegetation communities, affect the sensitivity of each site to fire, and determine the rate of post-burn growth. Knowledge of these site characteristics, in combination with knowledge of pre-burn plant communities, can assist managers in developing site-specific objectives and prescriptions for vegetation management and prescribed burning.

Ecological Land Classification systems for boreal Ontario provide a convenient and consistent means of describing these site conditions and allocating sites during field inspections. The relationships of northeastern Ontario ecosites (Taylor *et al.* 2000) and northwestern Ontario ecosites (Racey *et al.* 1996) to gradients of soil moisture regime and plant species richness are illustrated in Figure 4.

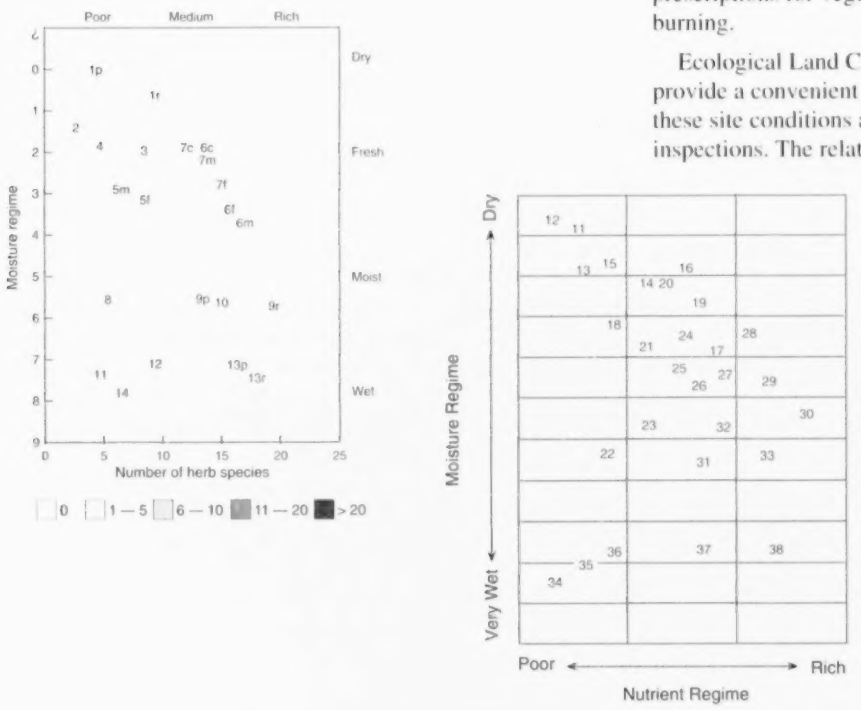


Figure 4. Northeast (left) and northwest (right) edaphic grids showing relative relationships between ecosite richness and moisture regime.

Table 1. Plant characteristics and responses to prescribed fire for selected forest plant species in boreal Ontario.

Common name	Rooting zone	Primary mode of vegetative reproduction	Primary seed dispersal method	Seed banking capability	Response to fire	
					Low severity	Medium to high severity
Trees						
Balsam poplar	mineral	root suckers	wind, water	no	↑	—
Trembling aspen	mineral	root suckers	wind	no	↑	—
White birch	mineral	root collar sprouts	wind	no	↑	↓
Jack pine	mineral	nil	wind, wildlife	2-3 years	—	↑
Red pine	mineral	nil	wind	2 years	—	↑
White pine	mineral	nil	wind, wildlife	no	↑	↑
Black spruce	organic/mineral	layering	wind, wildlife	no	—	↑
White spruce	mineral	nil	wind, wildlife	no	↑	↓
Balsam fir	organic/mineral	nil	wind, wildlife	no	↓	↓
Shrubs						
Beaked hazel	organic	root suckers	wildlife	no	↑	↓
Bush honeysuckle	mineral	rhizomes	wildlife		↑	↓
Mountain maple	organic	root collar sprouts	wind		↑	↓
Speckled alder	organic/mineral	root collar sprouts	wind, water		↑	↑
Green alder	mineral/organic	root collar sprouts	wind	no	↑	↓
Serviceberry spp.	mineral/organic	root collar sprouts	wildlife	several years	↑	↑
Sweet fern	mineral	rhizomes	wind	70 years	↑	↑
Red-osier dogwood	mineral	stolons	wildlife	several years	↑	↓
Honeysuckle spp.	mineral/organic	lower stem sprouts	wildlife		↑	↓
Pin cherry	mineral	root suckers	wildlife	100 years	↑	—
Choke cherry	mineral	root suckers	wildlife		↑	—
Gooseberry/currant spp.	mineral	stolons	wildlife	yes	↑	↓
Sheep laurel	mineral/organic	rhizomes	wind		↑	↓
Bog laurel	mineral/organic	rhizomes	wind		—	—
Labrador-tea	organic	stolons	wind		↑	↓
Prickly wild rose	mineral	rhizomes	wildlife	several years	↑	↓
Wild red raspberry	mineral	rhizomes	wildlife	50-100 years	↑	↑
Willow spp.	organic/mineral	root collar sprouts	wind, water	no	↑	—
Red-berried elder	mineral/organic	lower stem sprouts	wildlife	several years	↑	↓
Mountain ash spp.	mineral/organic	(root collar sprouts *)	wildlife	yes	↑	↓
Low sweet blueberry	organic/mineral	rhizomes	wildlife		↑	—
Velvetleaf blueberry	organic/mineral	rhizomes	wildlife		↑	—
Squashberry/highbush cranberry	mineral	root collar sprouts	wildlife	yes	↑	↓

↑ promotes ↓ controls - no change.

* these species are known to reproduce vegetatively by the methods indicated, but their primary mode of reproduction is by seed dispersal.

Table 1 (con't.) Plant characteristics and responses to prescribed fire for selected forest plant species in boreal Ontario.

Common name	Rooting zone	Primary mode of vegetative reproduction	Primary seed dispersal method	Seed banking capability	Response to fire	
					Low severity	Medium to high severity
Herbs, Ferns and Graminoids						
Fireweed	mineral	(rhizomes *)	wind	no	—	↑
Bracken fern	organic/mineral	rhizomes	wind	50 years	↑	↑
Field bindweed	mineral	rhizomes	wind		—	↑
Large-leaved aster	mineral	rhizomes	wind		↑	—
Wild buckwheat	mineral	none (annual)	wind		—	↑
Canada blue-joint grass	mineral/organic	rhizomes	wind	2 years	↑	—
Grass spp.	mineral/organic	rhizomes	wind	2-4 years	↑	↑
Sedge spp.	mineral/organic	rhizomes	wind	yes	↑	↓

↑ promotes ↓ controls - no change.

* these species are known to reproduce vegetatively by the methods indicated, but their primary mode of reproduction is by seed dispersal.

Table 2 on page nine provides an example of applying ecosite information to predict the effects of prescribed burning. Ecosites have been grouped into similar vegetation and site characteristics. Duff removal objectives to promote or control selected plant species associated with each class are also presented.

Post-fire Successional Trends

Succession is the process by which a forest regenerates itself following disturbance, and is also the changes in vegetation communities over time. In the boreal forest, there are a variety of possible post-fire successional pathways, depending on site conditions, pre-burn species composition and condition, and variations in fire severity and frequency (Alexander and Euler 1981).

The composition of pre-burn vegetation communities affects post-burn succession. Vegetation present on the site before the fire provides reproductive structures that will survive a fire to varying degrees, depending on its severity. Nearby communities provide additional seed sources. Burned stands tend to regenerate to the same tree species that were dominant before the fire, leading Methven *et al.* (1975) to conclude that in the boreal forest "there is no succession in the normal sense of the word, only a cycling of the forest by fire". High severity fires tend to favor the re-establishment of conifers with serotinous or semi-serotinous cones (jack pine and black spruce), while low severity fires tend to favor the re-establishment of hardwoods (poplars and white birch) and woody shrubs that reproduce by suckering, sprouting, or seed banking. Tree species that grow more slowly in the early years (balsam fir and white spruce) tend to become re-established over a longer period of time following fire, and only become abundant in later successional phases (Kelsall *et al.* 1977, Halpern 1989).

With respect to understory plants, the effects of fire tend to be changes in relative abundance and dominance rather than changes in species composition. Repeated fires can alter this trend by depleting on-site sources of regeneration (e.g. buried seeds, rhizomes, and sprouts), as well as the carbohydrate reserves of surviving plants over time (Ahlgren 1960). Schafi and Yarranton (1973) described three stages in early post-fire succession in the Ontario Clay Belt:

- 0-1 year: initial heterogeneity, characterized by the rapid growth of invading species (mainly herbaceous seed plants like fireweed, grasses, and sedges, pioneer mosses, and liverworts);
- 1-4 years: early phase, during which understory herbs and shrubs that were previously present on the site re-establish and increase in abundance;
- 4-11 years: late phase, during which the tree canopy begins to close, the understory species become shaded and decrease in abundance, and the community stabilizes.

Table 2. Ecosite groups and examples of duff removal objectives to promote or control selected common species.

Grouped northeast ecosites	Grouped northwest ecosites	General description	Common understory species	Promote common understory species	Control common understory species
ES 2, 4, 5f, 5m	ES 13, 15, 18, 20, 26	Dry to fresh pine/spruce, herb poor, ericaceous shrubs, feathermoss, average duff depth 10 cm	Blueberry, Labrador-tea, bush honeysuckle, dwarf raspberry	< 5 cm < 50%	5-10 cm 50-80%
ES 8, 11	ES 22, 31, 35	Moist site with spruce, herb poor, ericaceous shrubs, Sphagnum/ feathermoss, duff depth 20 to 120 cm	Blueberry, Labrador-tea, sheep laurel	< 5 cm < 25%	5-10 cm maximum 25%
ES 3	ES 14, 19, 21	Dry to fresh upland mixedwoods, medium herbs and (low) woody shrubs, average duff depth 10 cm	Bush honeysuckle, blueberry, mountain maple, mountain ash, beaked hazel	< 5 cm < 50%	5-10 cm 50-80%
ES 6f, 6m, 6c, 7f, 7m	ES 16, 24, 25, 27, 28, 29	Fresh upland mixedwoods, medium to rich herbs and (tall) shrubs, average duff depth 10 cm	Mountain maple, beaked hazel, serviceberry, cherry, squashberry, raspberry, grasses	< 5 cm < 50%	5-10 cm 50-80%
ES 9p, 9r, 10	ES 23, 30, 32, 33	Moist hardwoods or mixedwoods, rich herbs and shrubs, duff depth 10 to 39 cm	Speckled alder, raspberry, grasses, serviceberries	< 10 cm < 50%	5-20 cm 50-80%
ST 12, 13p, 13r	ES 36, 37	Wet lowland conifers, medium to rich herbs and shrubs, duff depth 40+ cm	Speckled alder, Labrador-tea, grasses and sedges	N/A	10-15 cm maximum 25%

In a study by Crites (1998), a comparison of early successional plant communities following fire and harvesting in boreal mixedwood stands produced different successional trajectories. These preliminary studies indicate that managers implementing silvicultural prescriptions that emulate natural disturbances may have to use prescribed fire to obtain the desired plant communities on site.

Vegetation Management Strategies

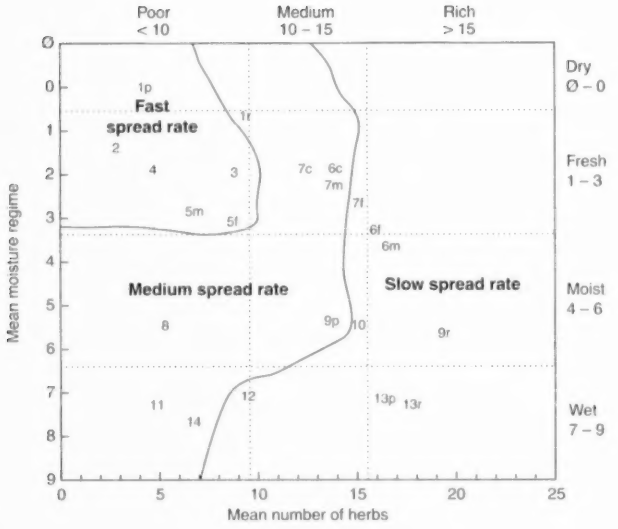
Use of fire as vegetation management tool in boreal stands has proven effective in reducing balsam fir competition and providing microsites for pine species regeneration (Crofts 1998).

A vegetation management strategy is developed as part of silvicultural planning, including regeneration, stand tending, and harvesting. A strategy begins with a clear understanding of goals and objectives for the management unit. Strategies address the process of possible alternatives from a combination of treatments that will give the best results. Prescribed fire is one treatment that can be chosen to prepare the site for regeneration of a stand. Vegetation management strategies should be formulated in advance, before the existing stand is harvested.

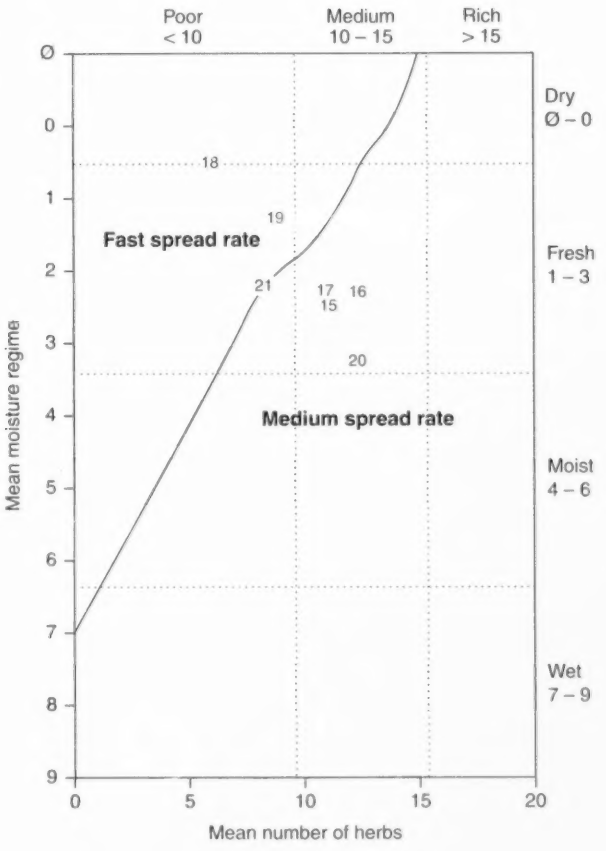
Anticipation of weed problems, selection of appropriate treatments, correct use of weed control techniques, and monitoring the results of treatments will help ensure the desired future forest is well established and growing optimally. Below are the basic steps for developing a prescribed burn prescription for vegetation management.

Step 1. Evaluate the Site

- Determine if the site lends itself to fire as an economical method of site preparation. In general, the larger the burn, the cheaper the cost.
- Look at the local topography for natural fire breaks. Lowland areas, downside sloping areas, lakes and rivers make inexpensive and effective boundaries for prescribed fire.
- Consider the shape of the site. Round or square areas are easier to ignite and control than rectangular.
- Establish the method of logging to be used. Limbing and topping in the bush as opposed to roadside provides sufficient fine fuels to successfully carry out a prescribed burn.
- Locate areas of concern in the prescribed burn area. Examples of areas of concern are: mining claims, lake and river reserves, private property, plantations, etc.
- Determine the Forest Ecosystem Classification ecosites and document prominent vegetation. This will give a good indication of available fuels and moisture regime. It will also indicate if you have to "brown" or "tramp" an area with herbicide before burning to ensure a successful prescription.
- Use tools such as the Northeast Ontario Post-harvest Fire Spread Class (below) or the photo guide to prescribed burn planning (Wearn *et al.* 1982) to help evaluate the site.



Northeast Ecosite 1p to 14



Northeast Ecosite 15 to 21

Northeast Ontario Post-harvest Fire Spread Class

This diagram groups the ecosites into three classes according to the predicted rate of fire spread (fast, medium and slow) following harvesting. The fire spread rates are based on the relative abundance of fire-resistant fuels (e.g. green vegetation) and the range of soil moisture regimes within the ecosite type groups. Fast spread rates are associated with dry to fresh, herb and shrub poor upland conifer sites. Medium spread rates are associated with dry to fresh upland sites with medium numbers of shrubs and herbs, and with moist to wet, herb and shrub poor lowland sites. Slow spread rates are associated with fresh to moist, herb and shrub rich mixedwood upland sites, and with wet, herb and shrub medium sites or rich lowland sites. Note that the actual rate of fire spread on a particular site will be affected by other factors, such as harvest method and timing (McCarthy *et al.* 1994).

Step 2. Formulate your vegetation management objectives

- Decide whether you need to promote or control vegetation on site. Check to ensure objectives are complementary to the management unit objectives.
- Determine if fire is the only site preparation treatment being used for a planting or seeding. If so, higher indices are required and the window of opportunity narrows.

Step 3. Develop your prescribed burn objectives

- Determine the amount of duff removal to fulfill vegetation management objectives. Duff removal is difficult in the spring, whereas fall burns tend to be deep burning fires with inherent mop-up problems.

Step 4. Develop your burn prescription

- Measure the amount of fuel left on site post harvest.
- Study the geographical features and topography.
- Determine burning indices, weather conditions and ignition method required to fulfill vegetation management objectives.

Prescribed fire is primarily used for two purposes. One is to promote a specific vegetation community and the other is to temporarily control certain competing species and promote crop tree growth. Either instance requires a full understanding of the prescription objective and the effects of fire on vegetation and site characteristics. Prescribed fire simulates the effects of wildfire and acts as a natural vegetation management tool. Natural resource managers need to recognize the important role fire plays in ecosystem management and incorporate (and conduct) prescribed fire as a regular site preparation method in Ontario.

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Literature Cited

Ahlgren, C.E. 1960. Some effects of fire on reproduction and growth of vegetation in northeastern Minnesota. Ecology 41(3): 431-445.

Alexander M.E. and D.L. Euler. 1981. Ecological role of fire in the uncut boreal mixedwood forest. In Boreal Mixedwood Symposium. Env. Can., Can. Forest Service, Great Lakes Forest Research Centre. Canada-Ontario Joint Forestry Research Committee Symposium Proceedings O-P-9. pp 42-65.

Arnup, R.W., B.J. Dowsley, L.J. Buse, and F.W. Bell. 1995. Field Guide to Autecology of Selected Crop Trees and Competitor Species in Northeastern Ontario. Ont. Min. Nat. Resour., Northeast Science & Technology, Timmins, Ont. NEST FG-005. 152 p.

Bell, F.W. 1991. Critical silvics of conifer crop species and selected competitive vegetation in northwestern Ontario. For. Can., Ont. Min. Nat. Resour., COFRDA Rep. 3310/Northwest Science & Technology, Tech. Rep. 19. 177 p.

Buse, L.J. and Bell, F.W. 1992. Critical silvics of selected crop and competitor species in northwestern Ontario. Ont. Min. Nat. Resour., NW Ont. For. Tech. Develop. Unit, Thunder Bay Ont. 134 pp.

Crites, S. 1998. In Wagner, R. G. and D. G. Thompson (Editors). Third International Conference on Forest Vegetation Management: Popular Summaries. Forest Research Information Paper No. 141. 508 pp.

Crofts, A.M. 1998. In Wagner, R. G. and D.G. Thompson (Editors). Third International Conference on Forest Vegetation Management: Popular Summaries. Forest Research Information Paper No. 141. 508pp.

Cushwa, C.T., R.E. Martin, and R.L. Miller. 1967. The effects of fire on seed germination. In Proc. 20th Ann. Meet., Am. Soc. Range Management, Seattle, WA, USA, Feb 16th, 1967. pp. 250-254.

Daubenmire, R. 1968. Ecology of fire in grasslands. Adv. Ecol. Res. 5, 209-266.

Flinn, M.A. and R.W. Wein. 1977. Depth of underground plant parts and theoretical survival during fire. Can. J. Bot. 55: 2550-2554.

Haeussler, S. and D. Coates. 1986. Autecological characteristics of selected species that compete with conifers in British Columbia: a literature review. B.C. Min. Forests, Victoria, B.C., FRDA Rep. No. 1. 180 p.

Haeussler, S. 1991. Prescribed fire for forest vegetation management. Synopsis. B.C. Min. For., Victoria, B.C., FRDA Memo No. 198. 19 p.

Halpern, C.B. 1989. Early successional patterns of forest species: interactions of life history traits and disturbance. Ecology 70(3): 704-720.

Kellman, M. 1970. The viable seed content of some forest soil in coastal British Columbia. Can. J. Bot. 48: 1383-1385.

Kelsall, J.P., E.S., Telfer and T.D. Wright. 1977. The effects of fire on the ecology of the boreal forest, with particular reference to the Canadian north: A review and selected bibliography. Can. Wildlife Serv., Ottawa, Ontario, Occasional Paper No. 32. 56 p.

Lavender, D.P., R. Parish, C.M Johnson,, G. Montgomery, A. Vyse, R.A. Willis, and D. Winston, 1990. Chapter 11: Site Preparation. In Regenerating British Columbia's Forests. p131-149.

Leck, M.A., V.T. Parker and R.L. Simpson. 1989. (Editors). Ecology of soil seed banks. Academic press, New York. 462 p.

McCarthy, T.G., R.W. Arnup, J. Nieppola, B.G. Merchant, K.C. Taylor, and W.J. Parton. 1994 Field guide to forest ecosystems of northeastern Ontario. Ont. Min. Natur. Resour., NEST Field Guide FG-001. 218 p.

McLean, A. 1969. Fire resistance of forest species as influenced by root systems. Journal of Range Management 22: 120-122.

McRae, D.J., M.E. Alexander, and B.J. Stocks. 1979. Measurement and description of fuels and fire behavior on prescribed burns: A handbook. Can. For. Serv. Dept. of the Environ. GLFRC, Sault Ste. Marie, Ont. Report 0-x-287. 44 p.

Methven, I.R., C.E. van Wagner, and B.J. Stocks. 1975. The vegetation of four burned areas in northwestern Ontario. Can. For. Serv., Petawawa Forest Exp. Stn., Petawawa, Ont. Info. Rep. PS-X-60. 23 p.

Racey, G.D., A.G. Harris, J.K. Jeglum, R.F. Foster and G.M. Wickware. 1996. Terrestrial and wetland ecosites of northwestern Ontario. Ont. Min. Natur. Resour., Northwest Sci. & Technol. Field Guide FG-02. 94 p. + Append.

Rowe, J.S. 1983. Chapter 8: Concepts of fire effects on plant individuals and species. In the role of fire in northern circumpolar ecosystems. John Wiley & Sons Ltd. p135-154.

Schafi, M.I. and G.A. Yarranton. 1973. Vegetational heterogeneity during a secondary (postfire) succession. Can. J. Bot. 51: 73-90.

Taylor, K.C., R.W. Arnup, B.G. Merchant, W.J. Parton, J. Nieppola. 2000. Field Guide to Forest Ecosystems of Northeastern Ontario: 2nd Edition. Ont. Min. Natur. Resour., NEST Field Guide FG-001.

Walstad, J.D. and Kuch (editors). 1987. Forest vegetation management for conifer production. John Wiley & Sons, New York, N.Y. 523 p.

Wearn, V.H., E.A. Springer and A.J. Lesage. 1982. Forest managers photo guide to prescribed burn planning. Ont. Min. Nat. Resour. Kapuskasing District, Kapuskasing, Ont. 72 p.

Wright, H.A. and A.W. Bailey. 1982. Fire Ecology: United States and Southern Canada. Wiley, New York.

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